# 2 ALTERNATIVES

# 2 ALTERNATIVES

This chapter summarizes the process of identifying feasible measures to restore the capability of Arrowrock Dam outlet works, identifies measures that were dropped from further consideration, and discusses the No Action and action alternatives.

The scoping process revealed that Federal and Idaho State agencies, private organizations, and interested individuals were primarily interested in the potential effects on natural resources and agriculture during the construction period and had little interest in the actual type or configuration of the valves. Tribal concerns include potential exposure of cultural resources during the anticipated drawdown(s) of Arrowrock Reservoir and potential impacts to bull trout. Irrigation districts were concerned about valve configuration to the extent that spaceholder costs would be affected. On this basis, the technical design selected for scoping was carried forward in each action alternative.

The focus of the description and evaluation of the effects of the alternatives in this document is the reservoir operations necessary for construction and future maintenance of the replacement outlet works at Arrowrock Dam and does not include optional type of valves or other outlet configurations. Short-term and long-term effects of the alternatives are discussed in chapter 3.

## Formulation of Alternatives

Reclamation has evaluated several technical conceptual designs since 1980. Much of the early planning effort was devoted to identifying specific engineering elements and combinations that would meet operational requirements (see appendix B).

In 1997, a Reclamation value engineering (VE) group, armed with new information on clamshell gates met to evaluate several new outlet valve configurations and options. The VE team identified three options that would meet operational objectives and would permit abandonment, or partial abandonment, of the sluice gates and all of the remaining Ensign valves. Based on costs and operational capability, the preferred option selected in this evaluation is replacement of the lower row of Ensign valves with seven 48-inch diameter and three 66-inch diameter clam shell gates. This option was developed into a conceptual design in1997 and presented to the public in the scoping process. The conceptual design and the VE team findings are summarized in *Arrowrock Dam, Outlet Works Rehabilitation Conceptual Design* (Reclamation, 1998b).

After extensive investigation, two alternatives appear viable for removing the lower row of Ensign valves. One alternative is to install **stoplogs** in the trashrack structures and draw Arrowrock Reservoir down to slightly below the top of the trashrack structures, effectively maintaining the water level above elevation 3027 feet (about 20 feet above the level of the other option) but limiting access to the valves and lengthening the construction period. The other alternative is to draw Arrowrock Reservoir down to elevation 3007 feet (about 4 feet below the floor of the trashracks) to allow access to all the valves simultaneously, reducing the period of construction and the period of extreme drawdown of Arrowrock Reservoir. These alternatives differ primarily in the length of the construction period and the reservoir level during the third

year of construction. The first alternative would provide a somewhat larger pool of water in Arrowrock Reservoir for environmental considerations while the second alternative is simpler from a construction viewpoint. Also, with the first alternatives there would be only a 15 percent probability of sluice gate operation as compared to a 100 percent probability with the other alternative. These action alternatives as well as the No Action Alternative are described in detail below.

## No Action Alternative

The No Action Alternative is defined as "the most likely future without the proposed action" and is the baseline for evaluating the effects of the action alternatives. In this case, the No Action Alternative is not the status quo operation scenario of the past 10 years.

Arrowrock Dam SOP states that the Ensign valves are to be inspected every 6 years and repaired as necessary. Although the valves in the upper row have received regular maintenance, maintenance work on the valves in the lower row has been deferred since 1988 due to high reservoir elevations and pending resolution of maintenance and valve replacement options. Currently, three of the lower valves are essentially inoperable, and the other seven valves and conduits continue to degrade. It is increasingly critical to repair the inoperable valves and to do maintenance work on the other seven valves to prevent possible valve failure. Two of the sluice gates are capable of only limited service due to a deteriorated condition and the other gates are in need of repair. Although the sluice gates are needed for certain operations, the Arrowrock Dam SOP provides no guidelines on periodic inspection of the sluice gates, and the last overhaul was in 1950.

As a result, the No Action Alternative would consist of an intensive repair and rehabilitation program for the lower row of Ensign valves and the sluice gates. Periodic reservoir drawdowns, a drawdown every 6 years, would be necessary for working in the dry. Those drawdowns would be for longer durations than in the past because of the need for major overhaul of the lower Ensign valves and sluice gates and a more aggressive maintenance program. Stoplogs would need to be installed in the trashrack structure of the sluice gates when work is performed on the sluice gates; reservoir inflow would be passed through other sluice gates. Maintenance of the lower valves and sluice gates would be in accordance with the SOP. Historically, Arrowrock Reservoir was drawn down to elevation 3007 to accomplish inspection and repair of these valves. Specific information on how this would be accomplished can be found in appendix B (see pages B7-B8).

### Facilities

Valve components would be removed, repaired or remanufactured, and replaced for all valves. Intake ring damage would be repaired by welding, and steel liners which have suffered continued cavitation damage would be replaced. Major cavitation damage to concrete liners would be repaired as needed.

During the intensive repair and replacement program each sluice gate would be disassembled and overhauled.

Upper Ensign valves would continue to be inspected annually and repaired as needed. These valves would undergo a complete overhaul procedure as described for the lower Ensign valves. Maintenance of these valves does not require reservoir drawdown beyond normal operating elevations during the fall maintenance period.

**Maintenance and Replacement Schedule and Reservoir Drawdown**

The maintenance schedule shown in this section is based on known conditions of the facilities and professional judgement of what would most likely be needed to maintain those facilities in good operating condition for the long term after they have been completely overhauled.

The schedule for major overhaul and repair of the lower Ensign valves and the sluice gates to bring outlet facilities to full operational capability would require drawdowns in years 1, 3, and every sixth year thereafter is illustrated in figures 2-1 and 2-2. Drawdowns for inspection and repair would continue to be made at 6-year intervals for the life of the project. During drawdown of Arrowrock Reservoir for valve and gate maintenance, Lucky Peak Lake would not be allowed to rise above certain elevations, but these elevations would be within the range of normal fall and winter operation.

Table 2-2 summarizes required reservoir elevations for the overhaul and maintenance of the sluice gates and Ensign valves under the No Action Alternative.

**Table 2-2. No Action Reservoir Operation During Maintenance Years**

| Item Overhauled[1] | Required Reservoir Elevations | |
|---|---|---|
| | Arrowrock Reservoir | Lucky Peak Lake |
| Sluice gates (with stoplogs) | ≤2975 feet | ≤2962 feet |
| Lower Ensign valves (without stoplogs) | ≤3007 feet | ≤2962 feet |
| Upper Ensign valves | ≤3101 feet | ≤3055 feet |

[1] Trashrack structures for the sluice gates and the lower Ensign valves allow the placement of stoplogs to exclude water up to the top of the trashrack structure.

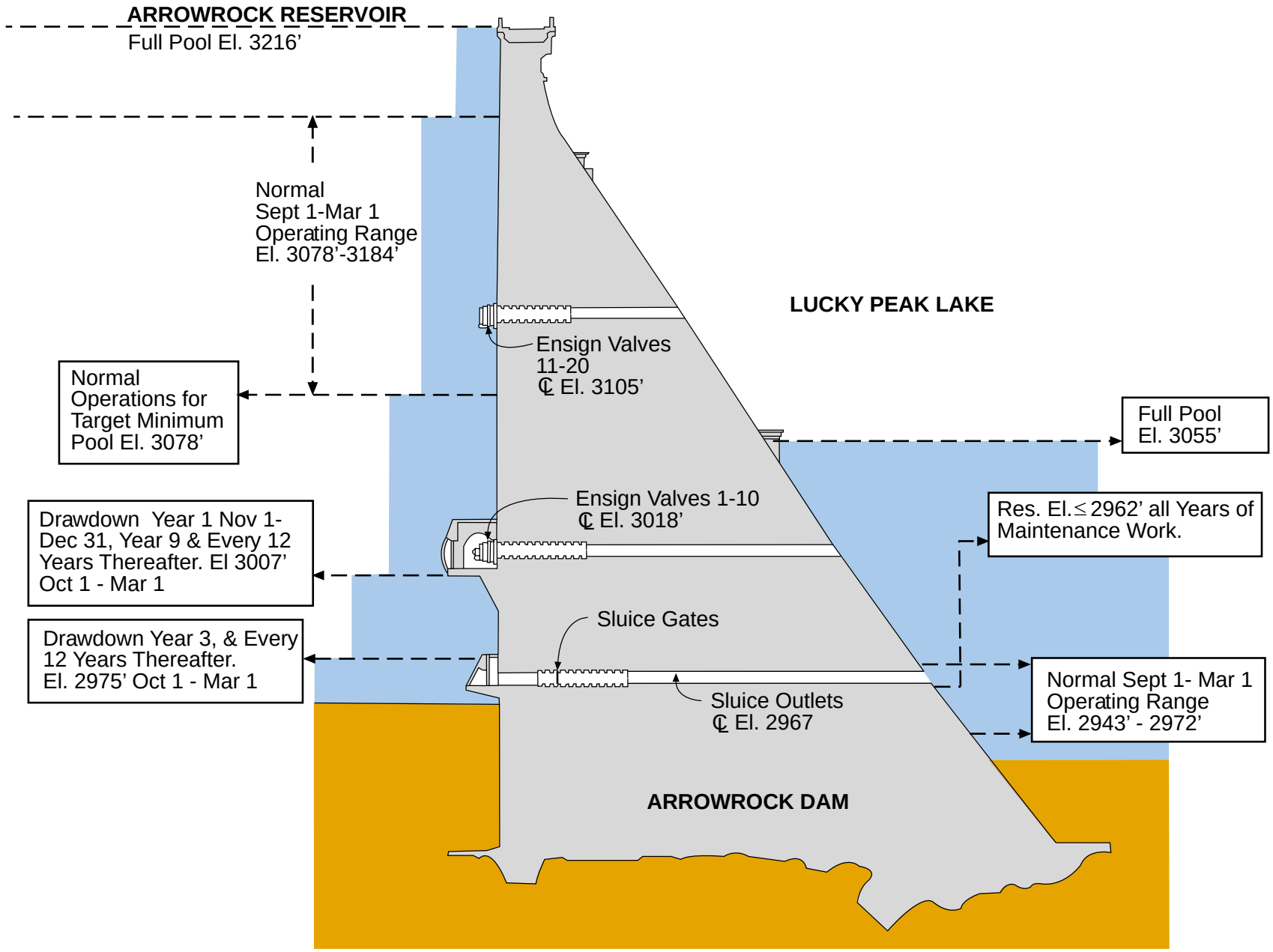
The drawdowns and the activities required for maintenance of the sluice gates and the lower row of Ensign valves are summarized in table 2-3. Maintenance activities related to the upper Ensign valves are not included as no special drawdowns are needed.

Figures 2-3, 2-4, and 2-5 are upstream and downstream view of Arrowrock Dam that provide a visual reference of a deep drawdown of Arrowrock Reservoir.

| Table 2-3. No Action Maintenance Schedule (Shaded Area Indicates Reservoir Drawdown for Maintenance)[1] | | | | | | |
|---|---|---|---|---|---|---|
| | Month | | | | | |
| Year | October | November | December | January | February | March - September |
| 1 | | Inspect downstream side of sluice gates<br>Inspect Ensign valves 2-10 and make minor cavitation repairs<br>Reservoir elevations November 1 - January 1:<br>Arrowrock – 3007 feet<br>Lucky Peak – 2962 feet | | Evaluate findings , prioritize activities, and draw up detailed plans | | |
| 3 | Overhaul sluice gates 3 and 5<br>Overhaul Ensign valves 2, 3, and 4<br>Inspect and make minor repairs to Ensign valves 5-10<br>Reservoir elevations October 1 - March 1:<br>Arrowrock – 2975 feet, Lucky Peak – 2962 feet | | | | | |
| 9 | Overhaul Ensign valves 5, 6, 7, and 8<br>Inspect and make minor repairs to Ensign valves 2, 3, 4, 9, and 10<br>Reservoir elevations October 1 - March 1:<br>Arrowrock – 3007 feet, Lucky Peak – 2962 feet | | | | | |
| 15 | Overhaul sluice gates 1, 2, and 4<br>Overhaul Ensign valves 1, 9, and 10<br>Inspect and make minor repairs to Ensign valves 2-8<br>Reservoir elevations October 1 - March 1:<br>Arrowrock – 2975 feet, Lucky Peak – 2962 feet | | | | | |
| 21 | Continue maintenance schedule<br>Inspect Ensign valves 1-10 and make minor cavitation repairs and prioritize maintenance work<br>Prioritize work and disassemble, inspect, clean, and repair 3 or 4 Ensign valves<br>Assure that every Ensign valve is overhauled once each 18 years and sluice gates are inspected and repaired as necessary once every 12 years<br>Reservoir elevations October 1- March 1:<br>Arrowrock – 3007 feet, Lucky Peak – 2962 feet<br>for inspection and repairs of the lower Ensign valves.<br>Arrowrock – 2975 feet, Lucky Peak – 2962 feet<br>for inspection and repairs of the sluice gates. | | | | | |
| [1]Lucky Peak elevations do not represent a drawdown but only a maximum elevation within normal operating parameters | | | | | | |

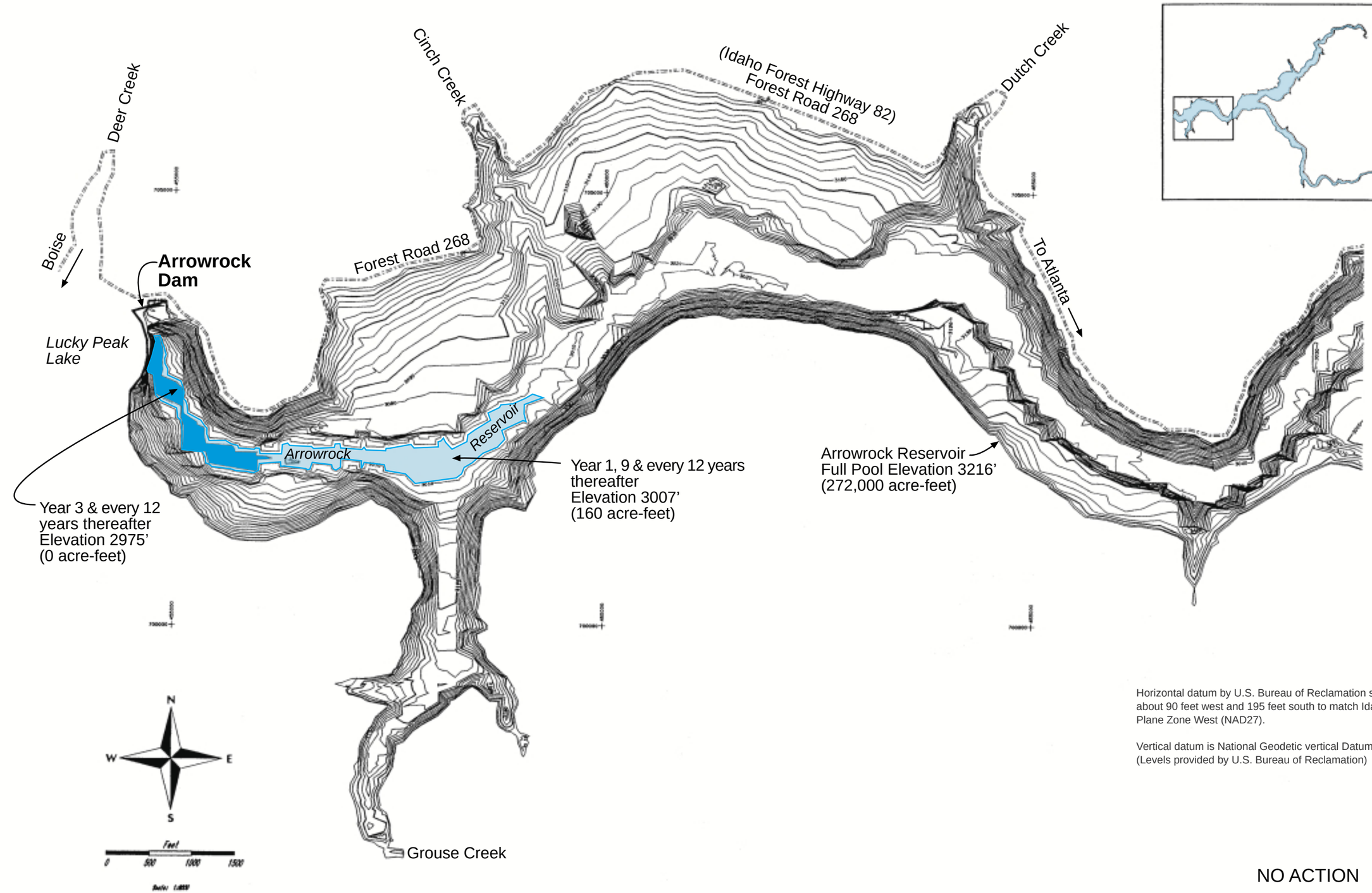
### Staging, Materials, and Waste Materials

The primary staging area for maintenance of the lower Ensign valves will be the top of Arrowrock Dam. It is anticipated that the No Action Alternative will not involve any hazardous or other waste materials. But if any are involved, they would be handled in accordance with current laws, regulations, and standard procedures.




**NO ACTION ALTERNATIVE**
**ARROWROCK DAM CROSS SECTION**

Figure 2-1




Horizontal datum by U.S. Bureau of Reclamation survey. Must be shifted about 90 feet west and 195 feet south to match Idaho's state Plane Zone West (NAD27).

Vertical datum is National Geodetic vertical Datum of 1929 (Levels provided by U.S. Bureau of Reclamation)

NO ACTION

ARROWROCK RESERVOIR ELEVATIONS

Figure 2-2

Figure 2-3. View of Arrowrock Dam looking upstream. The outlets of upper and lower rows of conduits controlled by Ensign valves are visible on the left and center; sluice outlets are submerged and not visible. Staging for construction would be on the level area to the right. Lucky Peak el. 2970 *(Oct 1987)*.

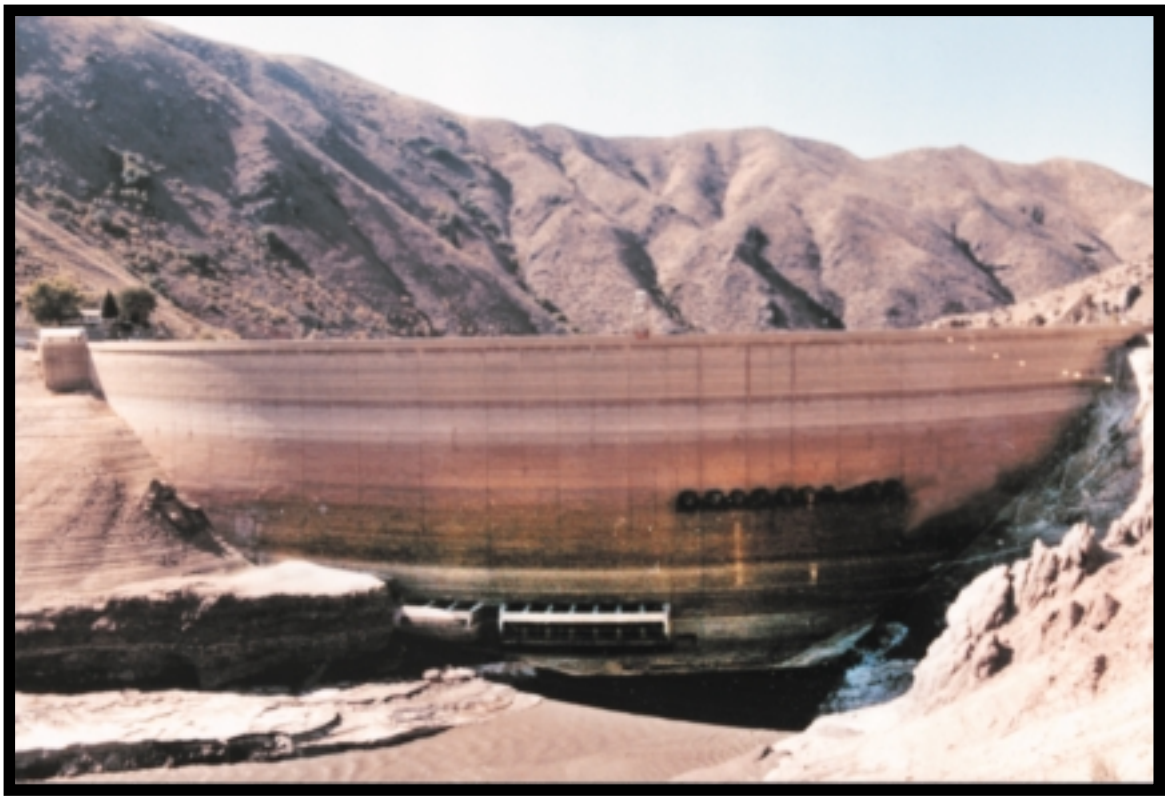


Figure 2-4. Looking downstream (west) at Arrowrock Dam from the north bank of the main stem Boise River. The estimated elevation of Arrowrock Reservoir is about 2985 feet (*Oct. 1987*)

Figure 2-5. Looking upstream (east) along the Boise River from the face of Arrowrock Dam. The high but unmeasured sediment load of the water is indicated by its chocolate coloring. The estimated elevation of Arrowrock is about 2985 feet. (*Oct. 1987*)

### Reservoir Operation in Years Between Scheduled Maintenance

In years other than those scheduled for reservoir drawdown to effect maintenance of the lower Ensign valves and the sluice gates, the operation of Arrowrock Dam and Reservoir would be based on water supply and irrigation demands. That is, during these years there would be no change from normal operating parameters.

### Costs

A 50-year life cycle cost analysis was made for the No Action Alternative. Capital costs are estimated at $34,300,000 and annual operation, maintenance, and replacement (OM&R) costs over a 50-year period are estimated to total $1,000,000. The capital cost estimate reflects periodic inspection and repair of the outlet facilities until all are fully operational. After that period continued inspection and repair as necessary are included in the OM&R estimate. The present worth value of the capital cost, assuming a 6.625 percent discount rate, is $11,000,000.

## Alternative A (Preferred Alternative) – Replace Lower Row of Ensign Valves with Clamshell Gates, Arrowrock Reservoir Elevation 3027 Feet in Construction Year 3

Reclamation has identified Alternative A as the as the Preferred and Environmentally Preferred Alternative. Alternative A consists of replacing the 10 lower Ensign valves located on the upstream side of the dam with clamshell gates (seven 48-inch and three 66-inch) to be located on the downstream side of the dam. Associated structures and features include a control house and new gallery entrance for access to the clamshell gates, steel conduit liners, modified trashracks to accept a **bulkhead gate** for maintenance of the outlets, and a **bubbler** system to maintain an ice-free area of water for the guides for the bulkhead gate. The top row of Ensign valves and the sluice gates would be abandoned. It is anticipated that one or two of the Ensign valves removed would be retained for subsequent use as an interpretive exhibit at a Reclamation facility. Construction would require 3 years with a drawdown of Arrowrock Reservoir below normal operating levels in year three for construction on the upstream face of the dam.

Alternative A provides the largest possible pool for Arrowrock Reservoir while still allowing construction in a dry condition. Six or seven valves would be operational at all times to pass flows. This would help reduce the need to use the sluice gates to pass reservoir inflow. As an additional measure to reduce the likelihood of needing the sluice gates, the work area on the upstream side of the dam would be allowed to flood during storm events for up to 5 cumulative days before sluice gates are opened. Additional details on facilities and construction schedule are in appendix B (see page B-8).

### Construction

Alternative A assumes a construction period of 3 years. Construction would require dry-site conditions which would be achieved through the use of stoplogs in combination with adjusting the levels of Arrowrock Reservoir and Lucky Peak Lake. To meet operational requirements and

complete construction in a 3-year construction period, construction would begin on September 15 and extend to March 1 in each year.

During the first 2 years, construction would be on the downstream face of Arrowrock Dam, and Lucky Peak Lake would be maintained at an elevation no higher than 3000 feet from September 15 to March 1. The elevation of Lucky Peak Lake must be held below this elevation during the first two construction seasons so that the contractor can access the lower levels Ensign valves on the downstream face of Arrowrock Dam and have access to a staging area just downstream (see figure 2-3). This elevation is lower than the normal elevation of Lucky Peak Lake during September but similar to winter month elevations.

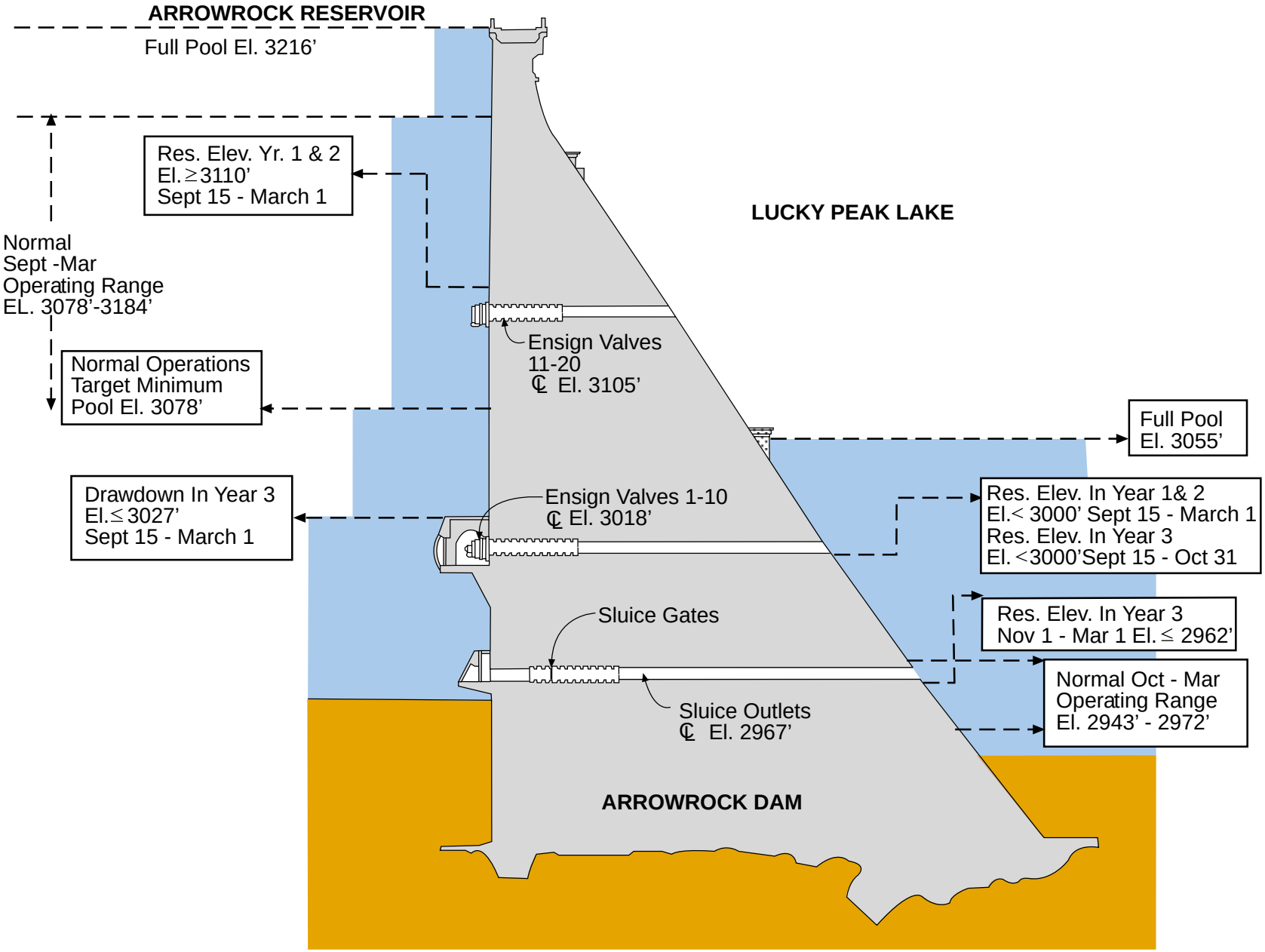
Arrowrock Reservoir, during the first 2 construction seasons, would be maintained at an elevation above 3110 feet from September 15 to March 1. This higher than normal fall elevation would be needed so that the upper row of Ensign valves will be below the surface of Arrowrock Reservoir, allowing these valves to be used to help pass upstream releases to meet downstream irrigation needs. Arrowrock Reservoir pool is normally drafted below the upper Ensign valves in the fall and refilled above the upper Ensign valves in the winter to avoid ice damage to the valves.

Access to the construction area would be across the new spillway bridge and the top of the dam to the road on the left abutment of the dam.

In the third construction season, activities would switch primarily to the upstream side of Arrowrock Dam. Arrowrock Reservoir would be drawn down and maintained at an elevation no higher than 3027 feet from September 15 to March 1. Lucky Peak Lake would be maintained at an elevation less than 3000 feet from September 15 to November 1 and would be maintained at an elevation of 2962 feet or less for the remainder of the construction season in case of a winter flood event. These Lucky Peak Lake elevations are somewhat below September levels but within normal winter operations. Figures 2-6 and 2-7 illustrate reservoir elevation and pool area during construction.

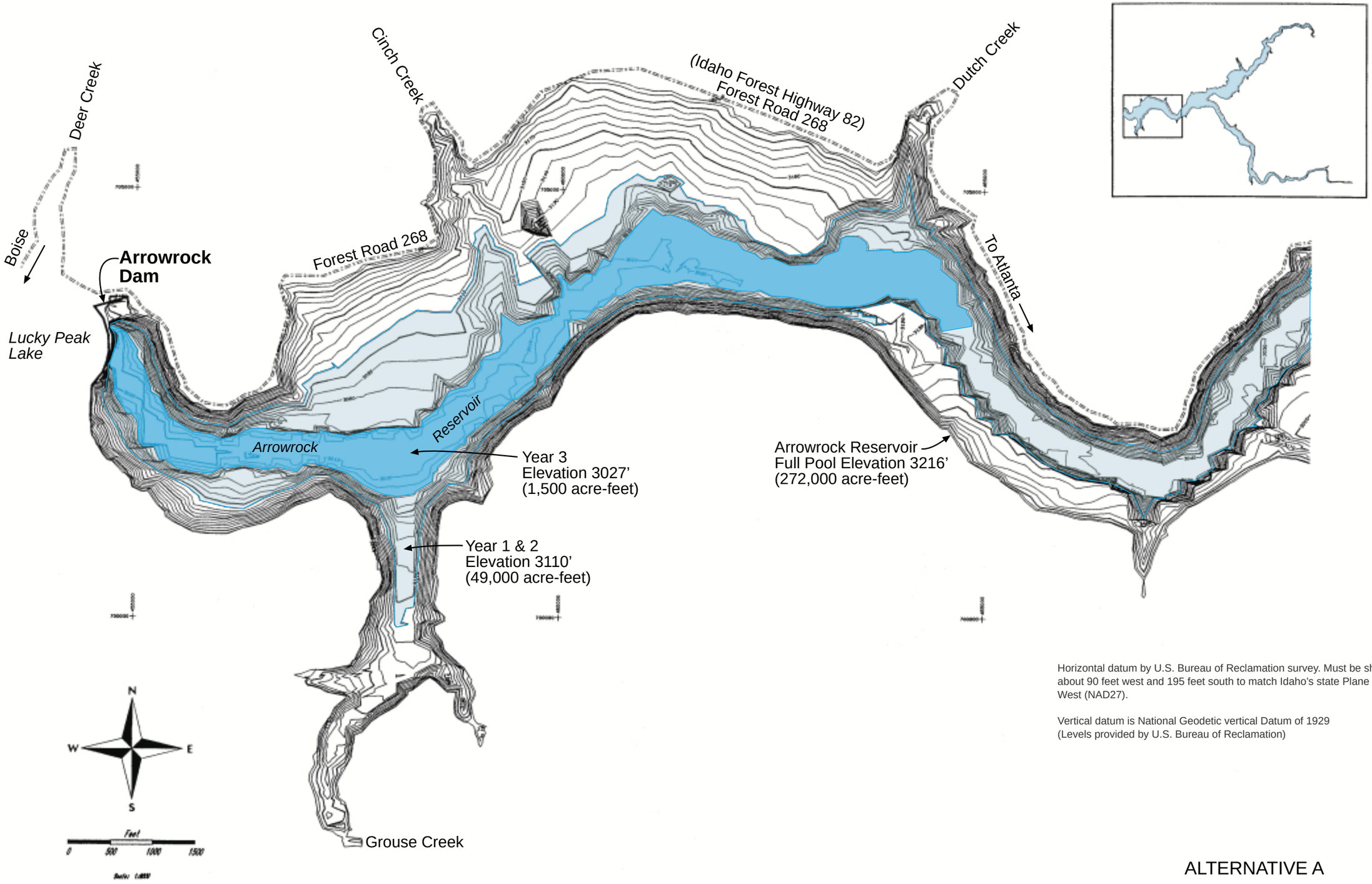
Inflow to Arrowrock Reservoir would be passed through the lower Ensign valves not being worked on and the completed conduits. It is anticipated that most winter storm events can be passed through these valves with the reservoir surface held at elevation 3027 feet. Use of the sluice gates would be avoided to the extent possible. However, sluice gates may be used if the construction work site is flooded more than 5 days cumulatively during the third construction. year. The probability of using the sluice gates is 15 percent.

The construction schedule and required reservoir elevations are summarized in table 2-4.




**ALTERNATIVE A**
**ARROWROCK DAM CROSS SECTION**

Figure 2-6




Horizontal datum by U.S. Bureau of Reclamation survey. Must be shifted about 90 feet west and 195 feet south to match Idaho's state Plane Zone West (NAD27).

Vertical datum is National Geodetic vertical Datum of 1929 (Levels provided by U.S. Bureau of Reclamation)

ALTERNATIVE A

ARROWROCK RESERVOIR ELEVATIONS

Figure 2-7

| Table 2-4. Construction Schedule for Alternative A (Preferred Alternative) (Shading Indicates Construction and Reservoir Drawdown)[1] | | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | Month | | | | | | |
| | September | October | November | December | January | February | March - August |
| 1 | | Mobilize for construction, excavate concrete for valves 1-3 and associated liners, place concrete for all gate structures and floor, and construct control house on downstream side of dam | | | | | |
| | | Arrowrock ≥ 3110 feet, Lucky Peak ≤ 3000 feet | | | | | |
| 2 | | Install steel liners and clam shell gates, place additional concrete for gate structures and roof, construct access tower, and install mechanical, electrical, and hydraulic controls | | | | | |
| | | Arrowrock ≥ 3110 feet, Lucky Peak ≤ 3000 feet | | | | | |
| 3 | | Install stoplogs, remove Ensign valves, install bell mouth liners and bulk head guides, and complete the installation of controls | | | | | |
| | | Arrowrock ≤3027 feet<br>Lucky Peak≤3000 feet | Arrowrock ≤3027 feet<br>Lucky Peak ≤ 2962 feet | | | | |
| [1]Lucky Peak elevations do not represent a drawdown but only a maximum elevation within normal operating parameters | | | | | | | |

**Staging, Materials, and Waste Materials**

Construction staging areas will be developed on the downstream side of Arrowrock Dam and on the top of the dam. Disturbances of vegetation and land form will be minimized to the extent possible; vegetation would be replaced and the land reformed in accordance with current regulations and standards. Figure 2-8 identifies potential staging areas.

All materials, hazardous and other waste, will be handled in accordance with current laws, regulations, and standard procedures. That includes containing runoff from concrete cutting and other construction activities. Concrete waste will be disposed by burying it on site above the highwater line (see figure 2-8).

Sand, gravel, rock, and other raw materials for construction are readily available from commercial sources in the area.

**Future Operation, Maintenance, and Replacement**

Future operation of the river/reservoir system after completion of construction would continue to be based on flood control, irrigation water supply, and other project operation requirements. Maintenance of the outlet conduits and clamshell gates would be achieved between irrigation seasons by lowering the bulkhead gate to the selected outlet to provide dry conditions for inspection and repair. It is anticipated that normal end of season elevations of Lucky Peak Lake would be suitable for maintenance activities; below the elevation of the clamshell gates. The

upper Ensign valves and the sluice gates would remain in place for historical reasons but would not be operated, and no future maintenance or repairs would be required.

### Costs

The estimated capital cost of Alternative A is $15 million. The present worth value of capital costs is $12,900,000. Total annual OM&R costs are estimated at $564,000 over a 50-year period.

## Alternative B – Replace Lower Row of Ensign Valves with Clamshell Gates, Reservoir Elevation 3007 Feet in Construction Year 3

Outlet works facilities to be replaced under Alternative B are identical to Alternative A (see also appendix B). The difference between Alternative A and Alternative B is the period of drawdown and elevation of Arrowrock Reservoir in third construction season. Alternative B assumes a drawdown of Arrowrock Reservoir to elevation 3007 feet for a 9-week period, September 1 through November 7, during the third construction season. An elevation of 3007 feet is below the level of the lower Ensign valves and would allow worker access to all of the lower row of Ensign valves simultaneously. This would effectively reduce the time needed for construction and the complexity of the construction effort. Since the construction period would be limited to a normally low precipitation period, there would be little potential of a large storm event inundating the work area during construction. The sluice gates would be used to pass all incoming flows.

### Construction

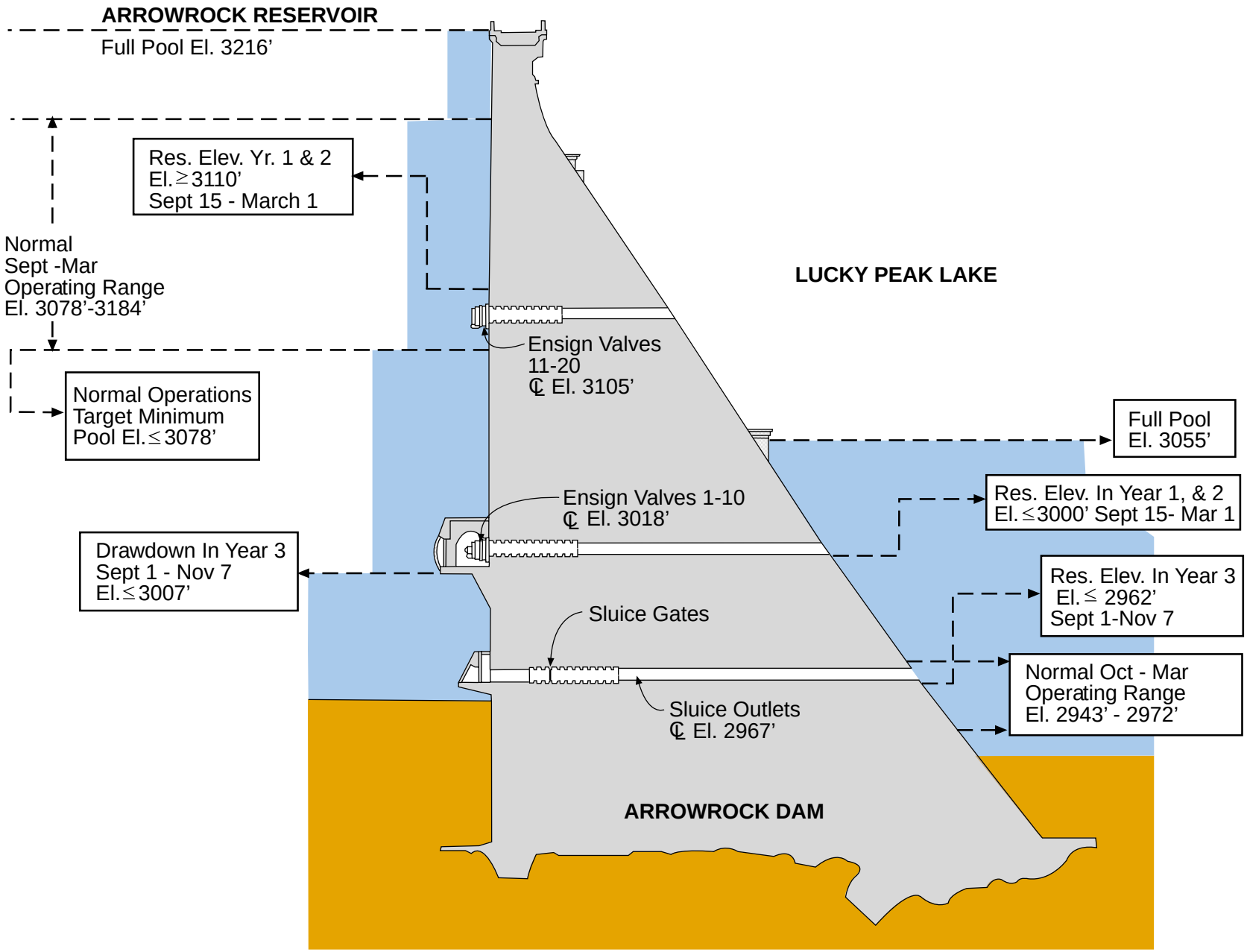
Alternative B assumes a construction period of 3 years and is identical to Alternative A except for the third year. In the third construction season, Arrowrock Reservoir would be maintained at elevation 3007 feet which is below the level of the Ensign valves and leaves only the sluice gates operational to pass flows. Lucky Peak Lake would be maintained at elevation no higher than 2962 feet which is below the elevation of the sluice gates. This elevation of Lucky Peak Lake would maximize the capacity of the Arrowrock sluice gates to pass flows. See figure 2-9 and figure 2-10 for illustrations of reservoir elevation and area during construction.

Completing construction in the 9-week period is critical as the likelihood of winter flood events that could not be handled by the sluice gates increases after this period. It is anticipated that prior to November 7 all inflow to Arrowrock Reservoir could be passed by the sluice gates. In the unlikely event that the work cannot be completed by November 7, stoplogs would be installed to isolate the uncompleted conduits to protect work areas from flooding. The completed conduits could be used to pass high inflows that surpass the capacity of the sluice gates.

The construction schedule and required drawdowns are summarized in table 2-5.

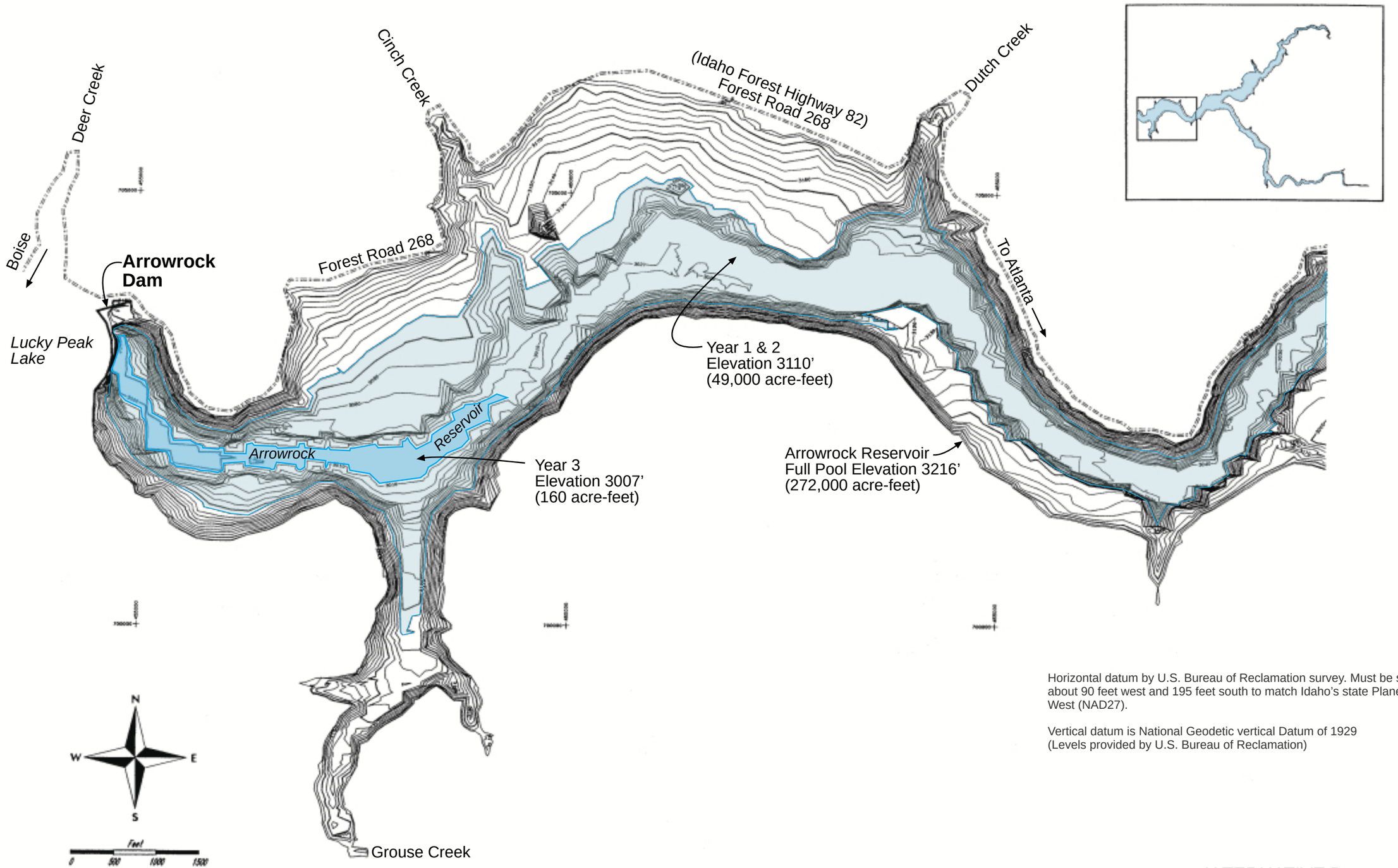

* These staging areas are dry during construction windows

Figure 2-8




**ALTERNATIVE B**
**ARROWROCK DAM CROSS SECTION**

Figure 2-9




Horizontal datum by U.S. Bureau of Reclamation survey. Must be shifted about 90 feet west and 195 feet south to match Idaho's state Plane Zone West (NAD27).

Vertical datum is National Geodetic vertical Datum of 1929
(Levels provided by U.S. Bureau of Reclamation)

ALTERNATIVE B

ARROWROCK RESERVOIR ELEVATIONS

Figure 2-10

| Table 2-5. Construction Schedule for Alternative B (Shading Indicates Construction and Drawdown)[1] | | | | | | | |
|---|---|---|---|---|---|---|---|
| Year | Month | | | | | | |
| | September | October | November | December | January | February | March - August |
| 1 | Mobilize for construction, excavate concrete for valves 1-3 and associated liners, place concrete for all gate structures and floor, and construct control house on downstream side of dam. | | | | | | |
| | Arrowrock ≥ 3110 feet, Lucky Peak ≤ 3000 feet | | | | | | |
| 2 | Install steel liners and clam shell gates, place additional concrete for gate structures and roof, construct access tower, and install mechanical, electrical, and hydraulic controls. | | | | | | |
| | Arrowrock ≥ 3110 feet, Lucky Peak ≤ 3000 feet | | | | | | |
| 3 | Remove Ensign valves, install bell mouth liners and bulk head guides, and complete the installation of controls. | | | | | | |
| | Arrowrock – 3007 feet<br>Lucky Peak ≤ 2962 feet | | | | | | |
| [1]Lucky Peak elevations do not represent a drawdown but only a maximum elevation within normal operating parameters | | | | | | | |

### Staging, Materials, and Waste Materials

Construction staging, materials, and handling waste materials under Alternative B would be identical to that under Alternative A (see figure 2-8 for staging and waste material disposal areas).

### Operation, Maintenance, and Replacement

Future OM&R would be identical with Alternative A.

### Costs

The estimated cost for Alternative B is $14,600,000. The present worth is value of the capital cost is $12,500,000. Total for OM&R is estimated at $564,000 over a 50-year period. The shorter construction time, ease of access to the Ensign valves, elimination of stoplogs, and reduced hazard in the third construction year would decrease the total construction costs.

## Alternatives Eliminated from Further Consideration

Several alternatives to replace the current Ensign valves with clamshell gates were identified and eliminated from further consideration. The differences among the alternatives are limited to the length and amount of drawdown and the method of providing dry working conditions.

Two-year construction periods, which would minimize the number of drawdowns for action alternatives, were examined. One alternative included a first year draw down of Lucky Peak to elevation 3010 (October through February) and a second year draw down of Arrowrock Reservoir to elevation 3026. The sluice gates would not be used. The other 2-year alternative included a first year draw down Lucky Peak to elevation 3010 (September through February) and a second year drawdown Arrowrock Reservoir to elevation 3026 (September through February). Sluice gates would be used in this second alternative. Both of the 2-year construction period alternatives were eliminated because a 2-year period was found to be of insufficient length to complete construction.

A primary concern expressed during scoping was the potential environmental effects of Arrowrock Reservoir drawdown needed to accomplish the work. Based on that input, Reclamation investigated methods of construction that would not require reservoir drawdown below normal fluctuation levels or would minimize drawdown. These alternatives focused on ways to reduce drawdown and to increase Arrowrock pool size during construction.

Reclamation formed a VE team in 1999 to evaluate costs, time frames, and various factors for achieving construction without drawdown of Arrowrock Reservoir. The value study team compared the construction scenario presented in the scoping process with three construction options that would require less or no drawdown through use of (1) a steel **cofferdam**, (2) an upstream pressure vessel, or (3) construction by divers (Reclamation, 1999b).

The upstream pressure vessel was eliminated because costs would be extravagant, in excess of three times the cost of the original construction concept. The cofferdam option and the dive option seemed feasible on first evaluation so were carried forwarded for further evaluation of constructability. In a Constructability Review (Reclamation 1999c), the cofferdam was determined to be infeasible based on (1) insufficient space to install the cofferdam within the trashrack compartment and still provide space to remove the components of the ensign valve structure, (2) problems in anchoring and sealing a larger coffer dam not supported within the trashrack structure, (3) difficult access by divers needed to properly seal the lower portion of the cofferdam, (4) a limited work area and leakage that would make high quality work difficult, (5) safety and rescue problems for workers related to the confined space and difficult access, and (6) costs presented in the Value Engineering Report (Reclamation 1999b) that did not account for many of the unknowns related to problems listed above and the unique nature of the work. Actual costs could be many millions of dollars more. A means of safely enlarging the size of the cofferdam to accommodate removal of the valves was not found. The ability to seal the cofferdam to the face of the dam appears limited with the potential for failure and a high level of risk to workers within the cofferdam during construction.

The Value Engineering Report (Reclamation 1999b) determined that underwater construction by divers on the upstream face of the dam would be technically feasible but it would (1) be costlier, (2) potentially require a second construction season for upstream work, (3) subject divers to safety risks while working near adjacent operating outlets, and (4) reduce the discharge capacity of adjacent outlets due to diver safety requiring either a delay or use of sluice gates during high inflows. Further evaluation determined that the costs estimated in the Value Engineering Report did not account for the many unknowns and risks involved and the proposal was eliminated as a feasible means of accomplishing the work (Reclamation 2000).

It is important to note that Lucky Peak Lake would need to be at or lower than 3000 feet elevation to allow access to the downstream side of Arrowrock Dam under all alternatives.

Information on technical concepts, including numbers and kinds of valves and various construction techniques, identified during the planning process are summarized in appendix B. This appendix identifies the reasoning for carrying some elements forward and for eliminating other elements from further consideration.

## Summary of Alternatives

The No Action Alternative requires drawdown of Arrowrock Reservoir in years 1 and 3 and every 6 years thereafter for the life of the project. In contrast, Alternatives A and B require only one drawdown of Arrowrock Reservoir during the life of the project; that drawdown would be in year 3 of the construction period. In addition, the drawdown of Arrowrock Reservoir under Alternative A would be no longer than that for year 3 of the No Action Alternative, and drawdown under Alternative B would be much shorter.

Modernizing the outlet works by installing new clamshell gates and mechanical equipment under Alternatives A and B would lower long-term maintenance costs and the risk of emergency situations due to failure of the old equipment. In contrast, Reclamation cannot with confidence state that overhaul of the existing 80-year old valves would result in operation free of malfunctions as we do not know what type of failures may occur with such old equipment.

Table 2-6 summarizes physical features and Arrowrock Reservoir drawdowns of the alternatives and table 2-7 presents a summary of impacts.

| Table 2-6. Summary of Alternative Facilities, Reservoir Elevations and Costs | | | |
|---|---|---|---|
| Item | Alternative | | |
| | No Action | A (Preferred) | B |
| **Facilities** | | | |
| Spillway | No change | No change | No change |
| Upper row of Ensign valves | Retained | Abandoned but left in place | Abandoned but left in place |
| Lower row of Ensign valves | Retained | Replaced with clamshell gates | Replaced with clamshell gates |
| Sluice gates | Retained | Abandoned but left in place | Abandoned but left in place |
| **Construction or Major Maintenance** | | | |
| 50 year period | 9 years (Years 1, 3, and every sixth year thereafter) | 3 construction seasons (parts of 4 water years) | 3 construction seasons (parts of 4 water years) |
| **Scheduled Arrowrock Reservoir Elevations (Elevations reflect Water/Reservoir Operations Modeling)** | | | |
| Total drawdowns (50-year period) | 9 | 1 | 1 |
| Year 1 (elevation) | 3007 feet for 2 months | >3110 feet | >3110 feet |
| Year 2 (elevation) | Normal operation | >3110 feet | >3110 feet |
| Year 3 (elevation) | 2975 feet for 5 months | 3027 feet for 5½ months | 3007 feet for 9 weeks |
| Year 9, 21, 33, 45 (elevation) | 3007 feet for 5 months | Normal operation | Normal operation |
| Years 15, 27, 39 (elevation) | 2975 feet for 5 months | Normal operation | Normal operation |
| **Scheduled Lucky Peak Lake Elevations (Elevations reflect Water/Reservoir Operations Modeling)** | | | |
| Total drawdowns (50-year period) | 9 | 3 | 3 |
| Year 1 (elevation) | 2962 feet for 3 months (November 7-December 31) | 3000 feet for 5½ months (September 15-March 1) | 3000 feet for 5½ months (September 15-March 1) |
| Year 2 (elevation) | Normal operation | 3000 feet for 5½ months (September 15-March 1) | 3000 feet for 5½ months (September 15-March 1) |
| Year 3 (elevation) | 2962 feet for 5 months (October 1-March 1) | 2962 feet for 5½ months (September 15-March 1) | 2962 feet for 9 weeks (beginning September 1) |
| Year 9, 15, 21, 27, 33, 39,45 (elevation) | 2962 feet for 5 months (October 1-March 1) | Normal operation | Normal operation |
| **Cost** | | | |
| Capital (present worth) | $11,000,000 | $12,900,000 | <$12,500,000 |
| Capital (50-year life cycle) | $34,300,000 | $15,000,000 | < $14,600,000 |
| Operation, maintenance, and replacement (50-year total) | $1,000,000 | $564,000 | $564,000 |

| Table 2-7. Summary of Impacts | | | |
|---|---|---|---|
| | Alternative | | |
| Item | No Action | A (Preferred) | B |
| **Water Quality** | | | |
| Arrowrock Reservoir | | | |
| Years affected | 9 of 50 years | 1 year | 1 year |
| Pool size | 0 and 160 acre-feet in alternate drawdowns | 1,500 acre-feet | 160 acre-feet |
| Sediment outflow | <520 to 1,250 acre-feet (each drawdown) | 0 to 10.5 acre-feet | Up to 1,250 acre-feet |
| Turbidity and total suspended solids | Temporary increase (each drawdown) | Temporary increase (less than No Action and B) | Temporary increase for shorter duration than No Action and A. (less than No Action) |
| Lucky Peak Lake | | | |
| Sediment inflow | <520 to 1,250 acre-feet in 9 of 50 years | 0 to 10.5 acre-feet in 1 year | Up to 1,250 acre-feet in 1 year |
| Sediment accumulation | <345 to 830 acre-feet in 9 of 50 years | 0 to 7.5 acre-feet in 1 year | Up to 830 acre-feet in 1 year |
| Turbidity and total suspended solids | Increase concentrations | Low levels unless sluice gates are operated | Increased concentrations |
| Total dissolved gases | Continued occasional elevated levels | Temporary increase in two construction seasons, long-term decrease | |
| Lower Boise River | | | |
| Main stem–Turbidity and total suspended sediment/solids | Exceed turbidity standard and Total Maximum Daily Load targets in 9 of 50 years | Turbidity standard and Total Maximum Daily Load target unlikely to be exceeded. May exceed during 1 year if sluice gates are used | Exceed turbidity standard and Total Maximum Daily Load targets in 1 year (shorter duration than No Action) |
| Lake Lowell–Turbidity and total suspended solids | Increased in 9 of 50 years | Probably no increase | Increase in 1 year |
| Anderson Ranch Reservoir, South Fork Boise River, and other Stream Reaches – No Impacts | | | |

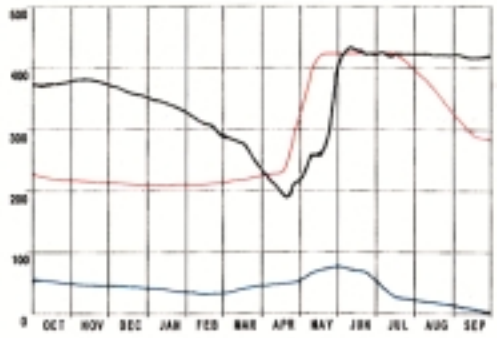
| Table 2-7. Summary of Impacts | | | |
|---|---|---|---|
| | Alternative | | |
| Item | No Action | A (Preferred) | B |
| **Endangered and Threatened Species** | | | |
| Bull Trout | | | |
| Mortality Risk | | | |
| Arrowrock Reservoir | High | Moderate | High |
| Lucky Peak Lake | Low[1] | Low[1] | Low[1] |
| Entrainment | | | |
| Arrowrock Reservoir | High | High (less than No Action) | High (less than No Action, greater than A) |
| Lucky Peak Lake | Low | Low | Low |
| Food Supply | | | |
| Arrowrock Reservoir | Total loss, 1-4 year recovery | Near total loss, 1-4 year recovery | Total loss, 1-4 year recovery |
| Lucky Peak Lake | Short term reduction | Minimal impact | Short term reduction |
| Bald Eagles | | | |
| Arrowrock Nesting Pair | | | |
| Food supply | Periodic short-term and long-term reduction | Short-term reduction | Short-term reduction |
| Productivity | Potential loss in 9 of 50 years | Potential loss (less than No Action and B) | Potential loss (less than No Action, greater than A) |
| Wintering Eagles | | | |
| Foraging opportunity | Degraded in some areas, enhanced in others (9 of 50 years) | Degraded in some areas, enhanced in others (less effect than No Action and B) | Degraded in some areas, enhanced in others (less effect than No Action, greater than A) |
| Gray wolf | No effect | | |
| Ute ladies'-tresses | No effect | | |
| Snake River salmon and steelhead | No effect | | |
| **Other Game Fish** | | | |
| Arrowrock Reservoir (risk of loss) | Significant for 2-3 years of every 6 year period | Significant for 2-3 years | Significant for 2-3 years (greater than A) |
| Lucky Peak Lake | Significant impacts from turbidity, 1 year of every 6-year period | Likely no effect | Significant impacts from turbidity for 1 year |

| Table 2-7. Summary of Impacts | | | |
|---|---|---|---|
| | Alternative | | |
| Item | No Action | A (Preferred) | B |
| **Vegetation and Wildlife** | | | |
| Waterfowl (loss of open water habitat) | Fall and winter of 9 of 50 years | Fall and winter of 1 year | Fall of 1 year |
| Shorebirds (foraging opportunity) | Enhanced in fall of 9 of 50 years | Enhanced in fall of 1 year | Enhanced in fall of 1 year |
| Fish eating species (foraging opportunity) | Hampered due to turbidity increase in 9 of 50 years | Hampered in 1 year (less effect than No Action and B) | Hampered in 1 year (less effect than No Action) |
| Vegetation | Minor clearing of upland areas for construction staging | | |
| **Irrigation Water Supply Shortage[2]** | | | |
| Number of times | 9 in 50 years | 1 year | 1 year |
| 4-year Cumulative Shortage – Total Shortages | | | |
| Wet period | 65,200 acre-feet | None | None |
| Average period | 121,600 acre-feet | 55,000 acre-feet | None |
| Dry period | 550,100 acre-feet | 478,700 acre-feet | 403,300 acre-feet |
| 4-year Cumulative Shortage – Specifically Due to the Alternatives | | | |
| Wet period | Not applicable | 0 acre-feet | 0 acre-feet |
| Average period | Not applicable | 55,000 acre-feet | 0 acre-feet |
| Dry period | Not applicable | 81,000 acre-feet | 5,600 acre-feet |
| **Recreation Effects** | | | |
| Arrowrock Reservoir (recreation-days) | Minimal loss in 9 of 50 years | Slight increase in 2 years, slight loss in 1 year | Slight increase in 2 years, slight loss in 1 year |
| Lucky Peak Lake (recreation-days) | Minimal loss in 9 of 50 years | Slight loss in 3 years | Minor loss in 2 years -103,100 in 1 year |
| Lower Boise River (recreation-days) | None | Significant loss in 1 year -43,750 in an average to dry year -175,000 in a wet year | Significant loss in 1 year -175,000 in a wet, average, or dry year |
| Anderson Ranch | Slight increase in recreation use | | |
| South Fork Boise River | No change in recreation use | | |

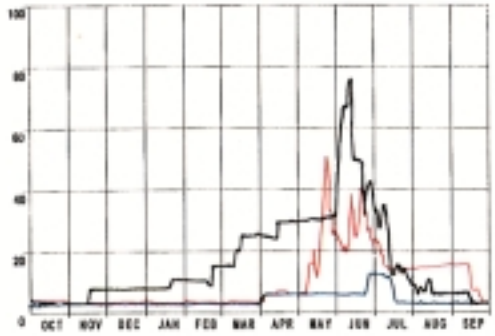
| Table 2-7. Summary of Impacts | | | |
|---|---|---|---|
| | Alternative | | |
| Item | No Action | A (Preferred) | B |
| **Economic Effects** | | | |
| Irrigation | Minor impacts in 9 of 50 years (not meaningful to calculate) | Minor impact in 1 year (less than No Action) | Very minor impact in 1 year (less than No Action and Alternative A) |
| Hydropower (4-year period) – Lucky Peak and Anderson Ranch Powerplants | | | |
| Generation | 1,772,585 megawatt-hours | 1,749,642 megawatt-hours | 1,744,015 megawatt-hours |
| Economic value<br>Low<br>High | <br>$45.6 million<br>$74.4 million | <br>$44.9 million<br>$73.1 million | <br>$44.5 million<br>$72.6 million |
| Incremental value (compared to No Action)<br>High<br>Low | <br>not applicable<br>not applicable | <br>-$740,000<br>-$1,285,000 | <br>-$1,115,000<br>-$1,786,000 |
| Recreation | | | |
| Arrowrock Reservoir | Very minor negative impact in late season in 9 of 50 years | Slight positive impact in 2 years and slight negative impact in 1 year | Slight positive impact in 2 years and slight negative impact in 1 year |
| Lucky Peak Lake | Minimal negative impact in 9 of 50 years | Minimal negative impact | Significant benefit loss of $3,702,900 due to reduced access to facilities |
| Lower Boise River | No effect under average water conditions. Negative effect during a wet year | Benefit loss of $314,100 in an average or dry year Benefit loss of $1,256,500 in a wet year | Benefit loss of $1,256,500 in an average or wet year |
| Anderson Ranch Reservoir | Slight positive impact to late season recreation use compared to normal operations due to higher reservoir elevation | | |
| South Fork Boise River | No effect to slight positive impact | | |
| Total recreation monetary loss | None | -$314,100 in an average or dry year<br>-$1,256,500 in a wet year | -$4,959,600 |
| **Financial Effects (Capital Costs)** | | | |
| United States obligation (54 percent of costs) | $18. 4 million over 50-year life | $8.1 million | $7.9 million |
| Arrowrock Reservoir spaceholder obligation (46 percent of costs) | $15.6 million paid over 50-year project life | $6.9 million paid through construction period | $6.7 million paid through construction period |

Figure 3-1 —Typical Content and Outflow of Boise Project Reservoirs

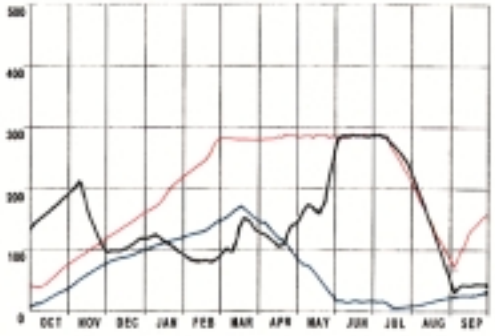
Contents of Anderson Ranch Reservoir
(1,000 acre-feet)



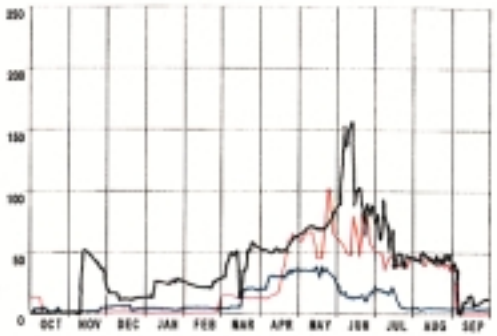

Outflow of Anderson Ranch Dam
(100 cubic feet per second)



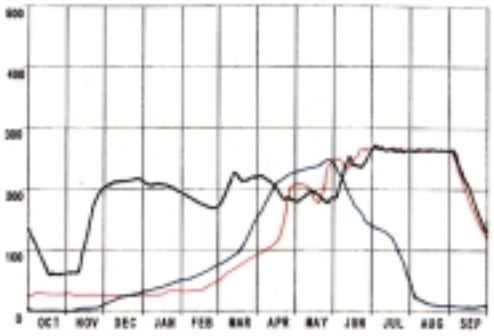

Contents of Arrowrock Reservoir
(1,000 acre-feet)



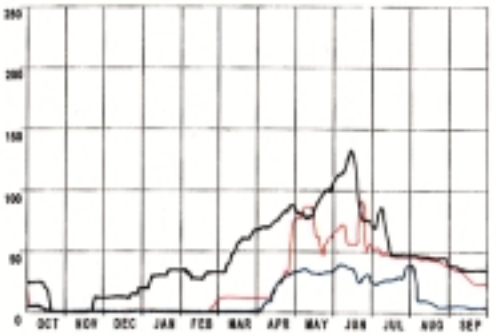

Outflow of Arrowrock Dam
(100 cubic feet per second)



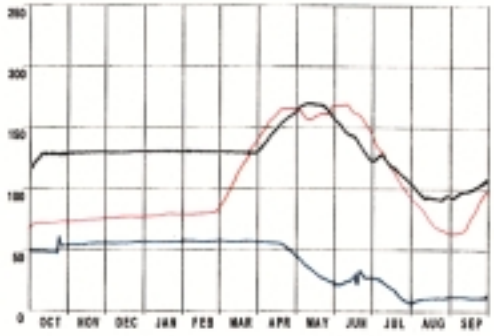

Contents of Lucky Peak Reservoir
(1,000 acre-feet)



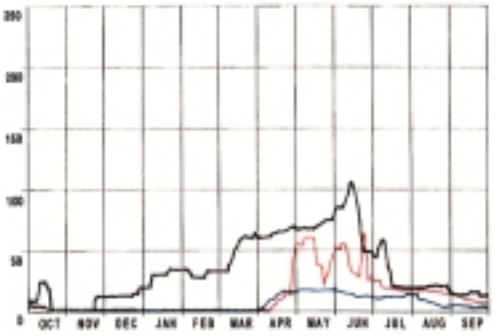

Outflow of Lucky Peak Dam
(100 cubic feet per second)




Contents of Lake Lowell (Deer Flat Dams)
(1,000 acre-feet)




Outflow of Boise R. Diversion Dam
(100 cubic feet per second)




1983 (Good water supply) 1980 (Average water supply) 1992 (Low water supply)

| Table 2-7. Summary of Impacts | | | |
|---|---|---|---|
| | Alternative | | |
| Item | No Action | A (Preferred) | B |
| **Effects on Cultural Resources** | | | |
| Archeological Sites/Traditional Cultural Properties | | | |
| Potential for physical disturbance due to erosion | Yes | Yes ( less than for No Action and B) | Yes (less than for No Action) |
| Potential for looting or vandalism | Yes | Yes | Yes |
| Historic Dam | Minor, non-visible impact | Removal of original elements and alteration of appearance. Largely mitigated | |
| **Effects on Indian Sacred Sites** | | | |
| Potential for physical disturbance due to erosion | Yes | Yes (less than for No Action and B) | Yes (less than for No Action) |
| Potential for looting or vandalism | Yes | Yes | Yes |
| **Effects on Indian Trust Assets** | | | |
| Right to hunt and fish | No Effect | | |
| **Cumulative Effects** | | | |
| Resources | No significant cumulative effect to any resource category | | |

[1]Higher risk for fish near Arrowrock Dam due to higher turbidity levels.
[2]Total annual diversion total by water condition are: wet period – 1,300,000 acre-feet; average period – 1,550,000 acre-feet; and dry period – 804,000 acre-feet.